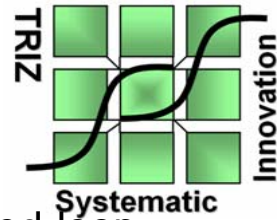# Innovative Leakage Safety Detection System using TRIZ

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INTEL Malaysia
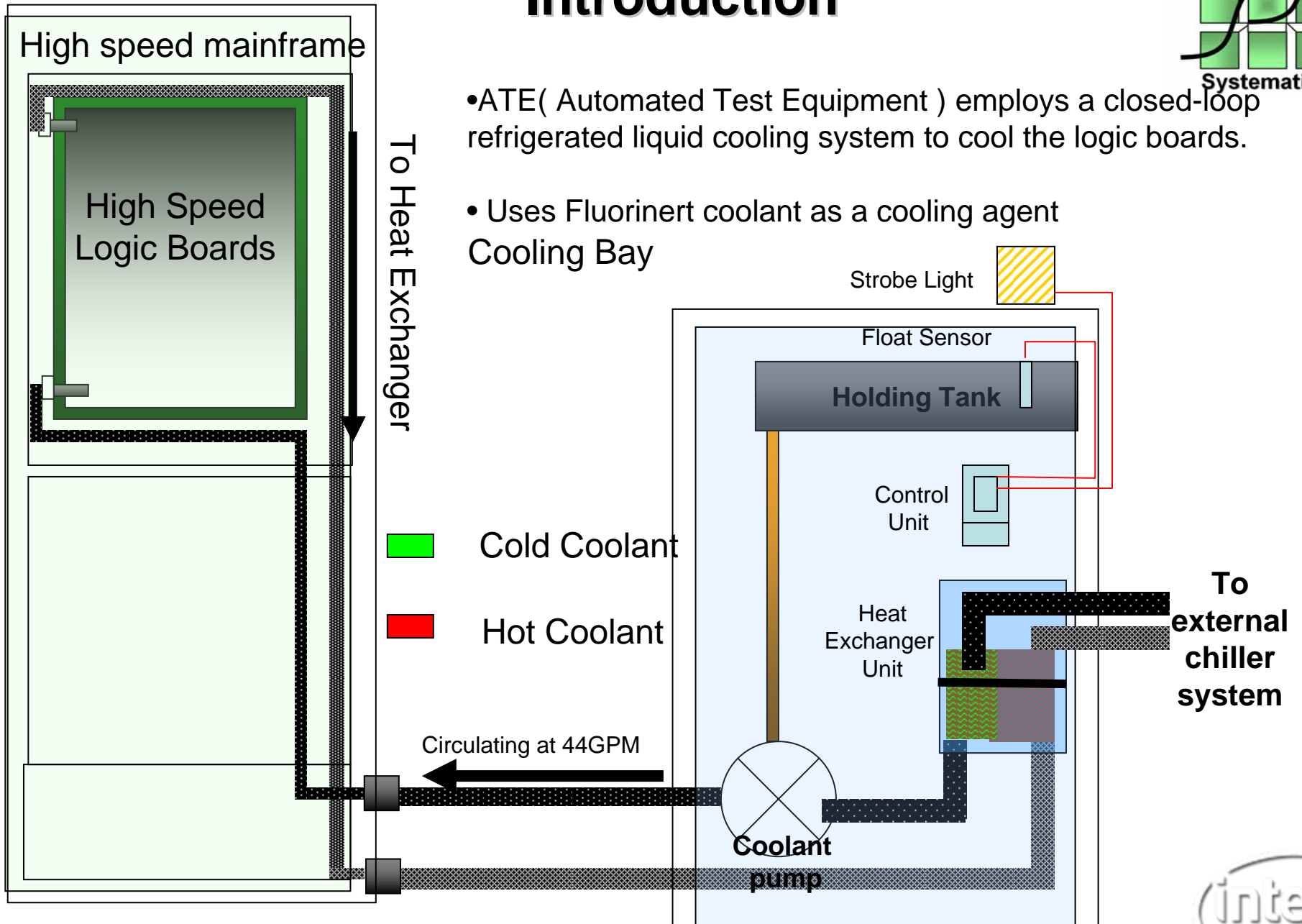
Introduction

High speed mainframe

High Speed Logic Boards

To Heat Exchanger

- ATE(Automated Test Equipment) employs a closed-loop refrigerated liquid cooling system to cool the logic boards.

- Uses Fluorinert coolant as a cooling agent
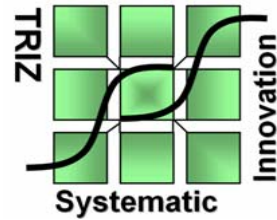
Cooling Bay

Strobe Light

Float Sensor

Holding Tank

Control Unit

Cold Coolant

Hot Coolant

Heat Exchanger Unit

To external chiller system

Circulating at 44GPM

Coolant pump
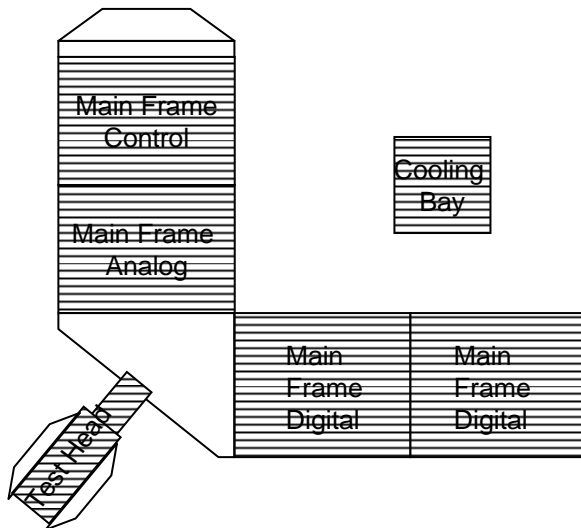
Overview of Cooling System

Current Situation

Fluorinert Coolant

- Fluorinert Coolant can create a severe **slip** hazard
- appears as **colorless** and **odorless** form of liquid
- has high **Evaporation rate**

Caution Slippery floor surface

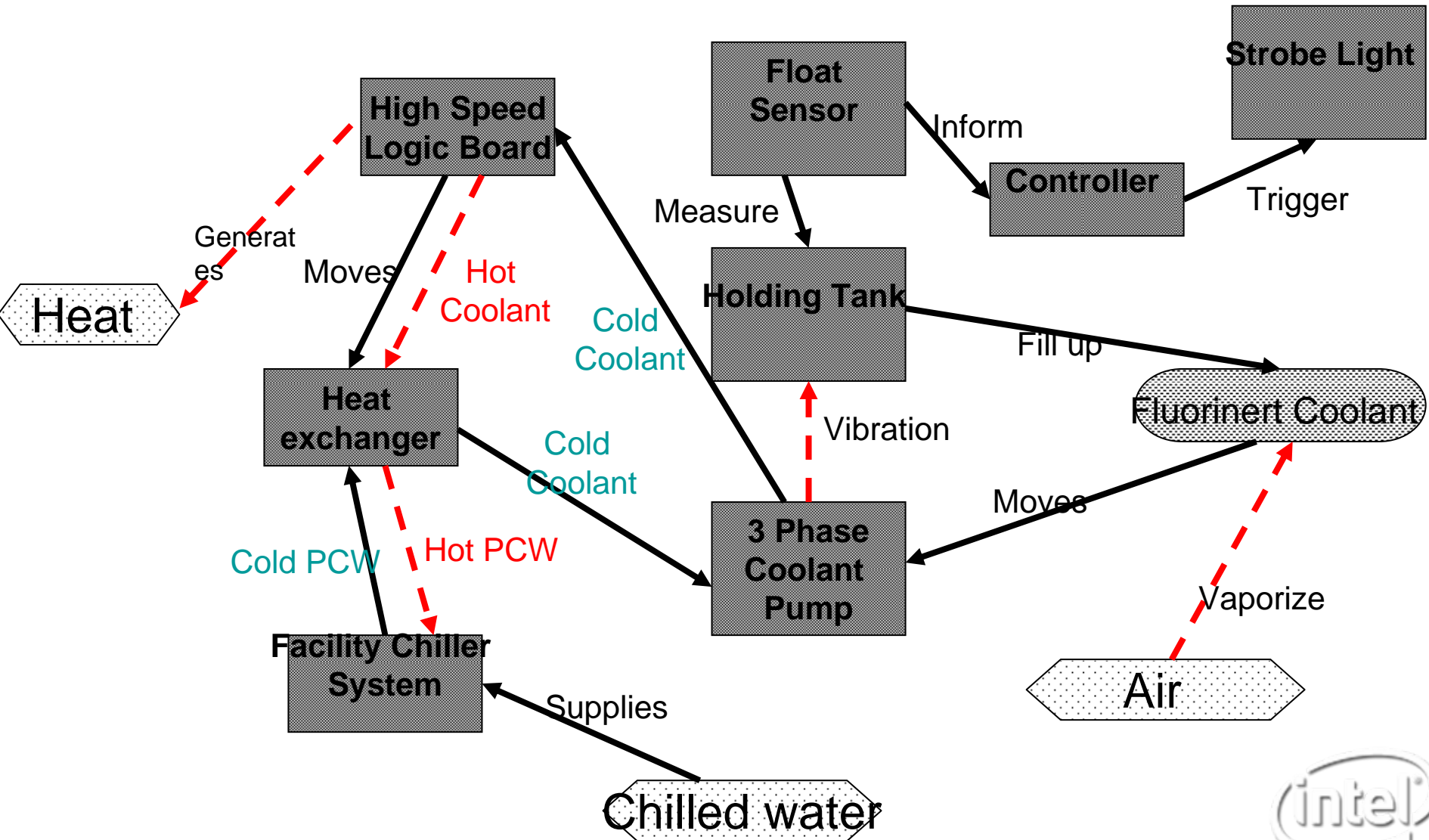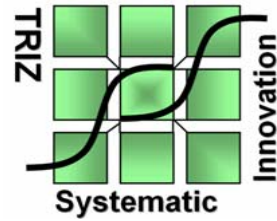## Automated Test Equipment Cooling System

- Cooling unit is **not** equipped with leakage detection System
- circulating at 44GPM and traveling over 300 square feet
- 800ml loss weekly due to natural losses
- The Fluorinert flowing thru hundreds of connectors and joints

Main Frame Control

Main Frame Analog

Cooling Bay

Main Frame Digital

Main Frame Digital

Test Head

Presence of Coolant Agent

Function Model
ATE-Tester Cooling System Functional Model

High Speed Logic Board

Float Sensor

Strobe Light

Float Sensor → Inform → **Controller**

Controller → Trigger → **Strobe Light**

High Speed Logic Board — Generates → Heat

Measure

High Speed Logic Board — Moves → Heat exchanger

Hot Coolant

Cold Coolant

Holding Tank

Holding Tank — Fill up → Fluorinert Coolant

Heat exchanger

Vibration

Cold Coolant

Cold PCW

Hot PCW

3 Phase Coolant Pump

3 Phase Coolant Pump — Moves → Fluorinert Coolant

Facility Chiller System

Air — Vaporize → Fluorinert Coolant

Chilled water — Supplies → Facility Chiller System

intel

Cause and Effect Chart

Reduce of Coolant volume in Tester Cooling System

Team focus on Coolant Leakage Detection
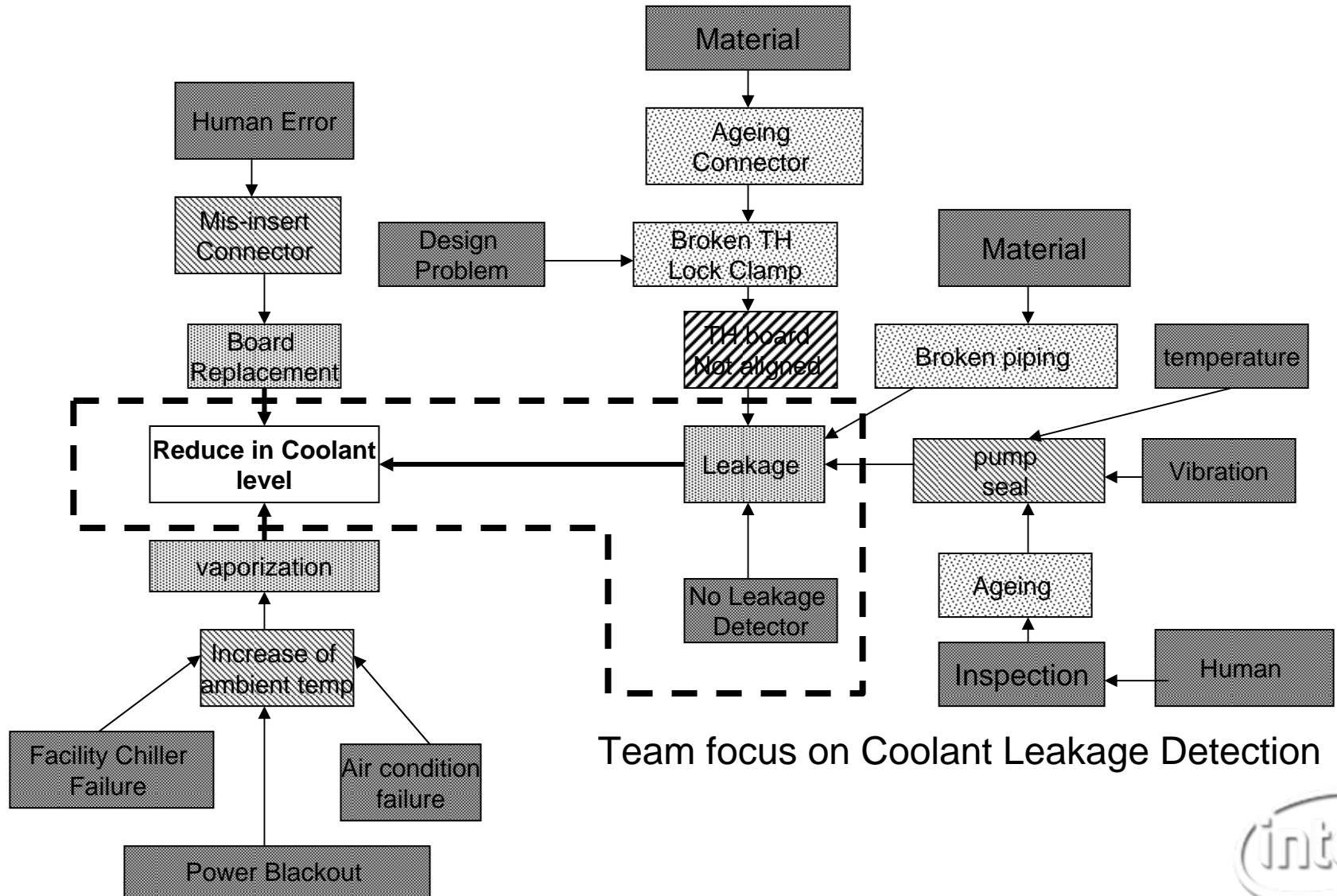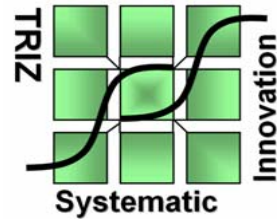
Problem Definition
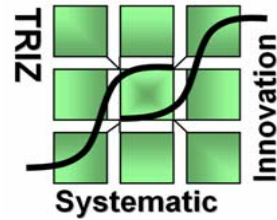
Original Problem Statement

Potential Safety incident because of coolant leakage

**Actual Problem Statement**

To design leakage detection system

Team Objective :

To avoid safety incident because of leakage or spills of coolant

Preliminary Design :

Incorporated High tech Solution in the system which capable of monitoring holding tank volume at real time and triggers when there is a drastic drop on the volume
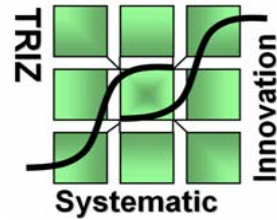
Ultrasonic Sensor

Coolant Holding Tank

Coolant height Measurement
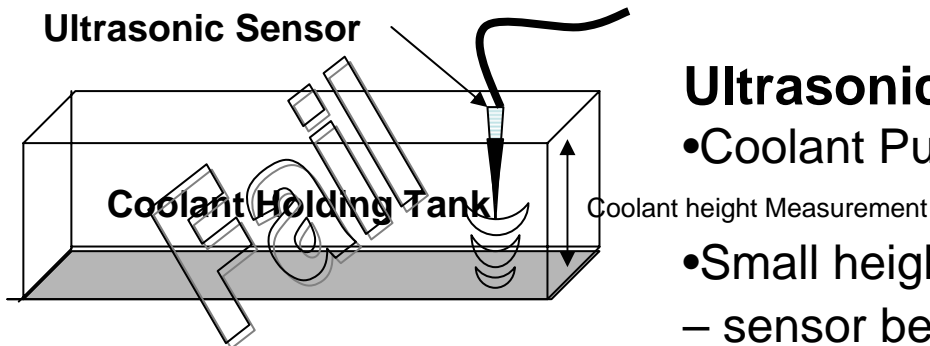
Ultrasonic sensor failed because of:-

• Coolant Pump generates ripples on the holding tank

• Small height change represent big volume of Coolant – sensor becomes oversensitive
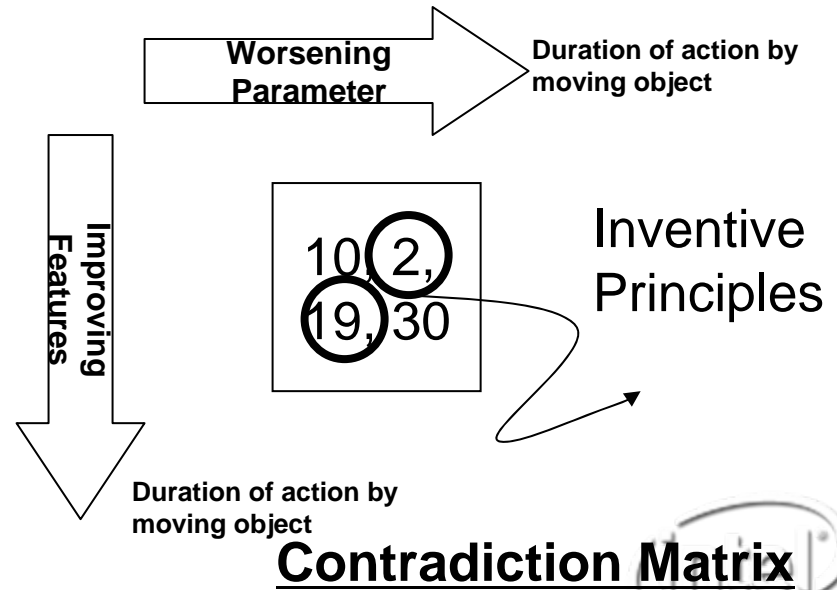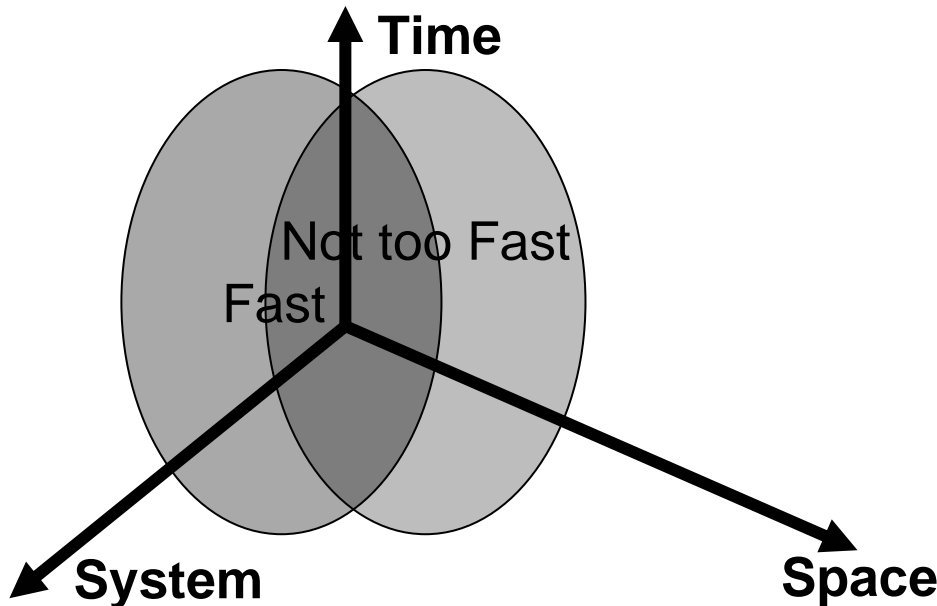
But With TRIZ .....

Engineering Contradiction

If detection system is able to detect leakages of Coolant then safety slip hazards can be avoided but the system should able to differentiate natural losses of the system

Physical Contradiction

Based on the volume measurement at the holding tank , only large spills of Coolant can be detected or measured

Time

Not too Fast
Fast

System

Space

Worsening Parameter → Duration of action by moving object

Improving Features

Duration of action by moving object

10, 2,
19, 30

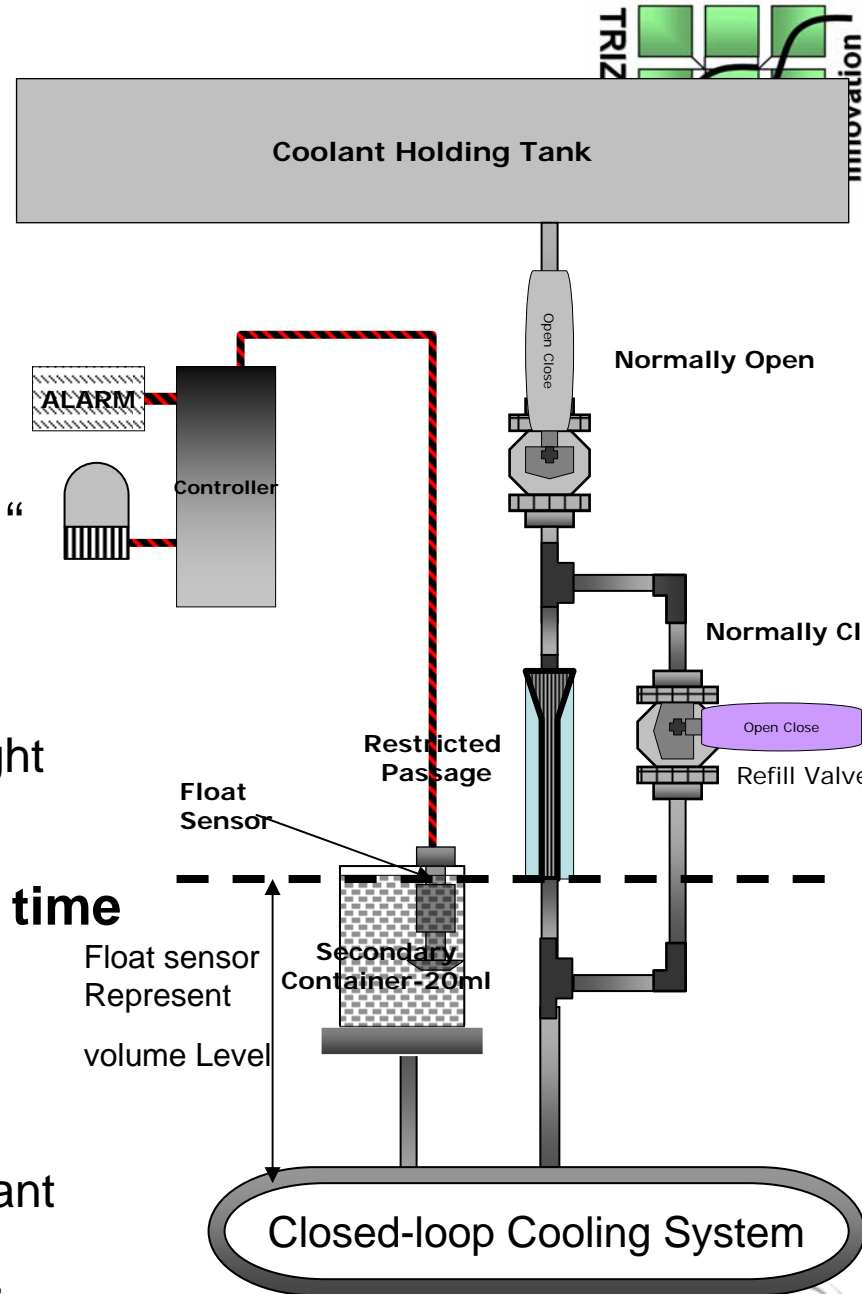Inventive Principles

Contradiction Matrix

Solution

Overcoming Physical contradiction
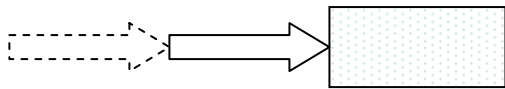
Separation of contradictory properties in space
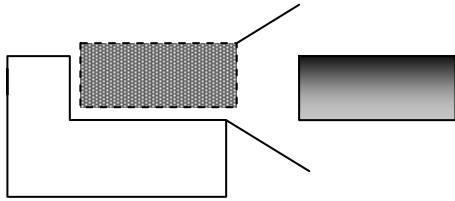
TRIZ inventive principles 2 – "Taking Out "
- A small secondary container(20ml)with float sensor represent the system Volume (based on Bernoulli Principles)
- Drop in Float will activate alarm and Strobe Light

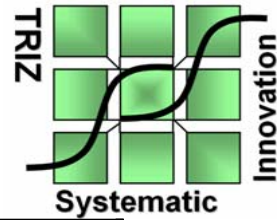## Separation of contradictory properties in time

TRIZ inventive principles 19 – "Periodic "

- Restricted passage dispense Coolant at constant rate to replenish natural loss (very slow)
- Slow down replenish during leakage for detection on secondary container

Coolant Holding Tank

Open Close

Normally Open

ALARM

Controller

Normally Cl

Open Close

Refill Valve

Restricted Passage

Float Sensor

Float sensor Represent

volume Level

Secondary Container-20ml

Closed-loop Cooling System

Summary

	Preliminary Design	With TRIZ
Duration	14 weeks	**3 Weeks**
Cost		**56% Cheaper** in comparison to Preliminary Design
Coolant Property Change	No	No
Existing Safety Feature	No Modification	No Modification
Volume Monitoring System	Minimum	Minimum
Effectiveness	Design Fail	**Ability to detect Small leakage**

TRIZ WORKS! – The innovative principle and problem and relationship analysis helps us to 'see' the problem without distractions